In the 1947 novel *Greener than you think* by the left-wing sci-fi writer Ward Moore, a mad scientist in L.A., Josephine Francis, recruits a down-and-out salesman named Albert Weener, described as having ‘all the instincts of a roach’, to help promote her discovery: a compound called ‘the Metamorphizer’ that enhances the growth of grasses and allows them to thrive on barren and rocky soils. She dreams of permanently ending world hunger through a massive expansion of the range of wheat and other grains. Weener, a scientific ignoramus, thinks only of making a quick buck, peddling the stuff door to door as a lawn treatment. Desperately needing cash to continue her research, Francis reluctantly agrees and Weener heads out to the yellowed lawns of tired bungalow neighbourhoods.

To his surprise the treatment, which alters grass genes, works – only too well. In the yard of the Dinkman family, crabgrass is converted into a nightmare ‘Devil Grass’, resistant to mowing and weedkillers, that begins to spread across the city. ‘It writhed and twisted in nightmarish unease ... inexorably enveloping everything in its path. A crack in the roadway disappeared under it, a shrub was swallowed up, a patch of wall vanished’ (Moore, 1947: 59). It continues to eat pavements and houses and finally consumes the city: a monstrous new nature creeping toward Bethlehem.

*Greener than you think* is both hilarious and slightly unnerving. But in the strangest of turns, its absurd premises are being turned into reality by climate change. Devil Grass is actually Bromus, a tribe of invasive and almost ineradicable weeds bearing appropriately unsavoury names such as ripgut brome, red brome, and cheat grass. (Their sinister allies from other tribes include scurges of medusahead, tall fescue, false brome, and barbed goat grass.) Invasion is an old California story. In the first wave, black mustard and oatgrass arrived from Europe in the Spanish period and thanks to overgrazing by wild cattle soon replaced native perennial grasses. The bromes, originating in the Mediterranean and the Middle East, came as a second wave in the late 1880s. They were described as a ‘contagion’ that ate away at the endless carpet of wildflowers whose spring displays in the
foothills and valleys had stunned early visitors and put ‘golden’ in the state’s nickname (Minnich, 2008). But now increased fire frequency and exurban sprawl have become the bromes’ Metamorphizers, allowing them to rapidly conquer and degrade ecosystems throughout the state.1

The Eastern Mojave Desert is a tragic example. En route from LA to Vegas and 20 minutes away from the state line, there is an exit from I-15 to a two-lane blacktop called Cima Road. It is the unassuming portal to one of North America’s most magical forests: countless miles of old-growth Joshua trees mantling a field of small Pleistocene volcanoes known as Cima Dome. The monarchs of the forest are 45ft high and centuries old. In mid-August 2020 an estimated 1.3 million of these astonishing giant yuccas perished in the lightning-ignited Dome Fire (Boxall, 2020). This is not the first time that the Eastern Mojave has burned, a megafire in 2005 scorched a million acres of desert but it spared the Dome, the heart of the ecosystem. Over the last generation, increasing invasions of red brome have created a flammable understory to the Joshuas and transformed the Mojave into a fire ecology (Underwood et al., 2019).2 (Invasive cheatgrass and wiregrass have played similar roles in the Great Basin and eastern Washington’s prairies for decades.) Most desert plants, unlike California oaks and chapparal, are not fire-adapted, so their recovery may be impossible. Debra Hughson, the chief scientist at the Mojave National Preserve, indeed described the fire as an extinction event: ‘The Joshua trees are very flammable. They’ll die, and they won’t come back’ (Olalde, 2020).

The invasive grass–fire cycle

Our burning deserts are regional expressions of a global trend: the fire-driven transformation and replacement of native land-cover from Greenland (where wildfires are now an annual event) to Hawai‘i. Even the Antarctic Peninsula now has an invasive weed problem (Hughes et al., 2020). In most cases, exotic plants – especially annual grasses and forbs – are the culprits. In southeastern US forests the devil is cogongrass from East Asia; in Australia, serrated tussock from South America; in Hawai‘i, guinea grass from Africa; and in Spain, pampas grass from the Rio Plata. But bromes, superbly adapted to the Anthropocene, rule the West Coast. As Travis Bean, a weed scientist at UC Riverside, warned in 2019: ‘We have all of the nasty non-native Bromus species here in California, and the ubiquitous weeds are key drivers of increasing fire frequency’ (Kan-Rice, 2019). Increased fire frequency, in turn, opens new spaces for the propagation of these fast-growing and easily dispersed species. Where mountain chapparal, for instance, requires 20 years after fire to restore biomass, bromes need only one or two
winters’ rain to sustain a large fire. Once established, the ensuing ‘invasive-grass–fire cycle’ is almost irreversible.

This is happening in all Mediterranean biomes, despite the fact that their vegetation has similarly coevolved with fire and requires episodic burns to reproduce. The current wave of annual extreme fire in the Iberian Peninsula, Greece, Australia, and California is overriding Holocene adaptations and pushing native ecosystems, many of them already degraded, past their survival tipping points. Southern California’s coastal sage scrub, for instance, is estimated to have lost 68 per cent of its area to bromes and other invading weeds (Martinson et al., 2008: 264). Although Australia is a close contender, it is California that best illustrates the vicious circle where extreme heat leads to frequent extreme fires that prevent natural regeneration and, with the help of tree diseases, accelerate the conversion of historic landscapes into parched grasslands and treeless mountain slopes. And with the loss of native plants goes much of the native fauna, from salamanders to owls.

Climate change drives landscape conversion in several different ways. From an earth-system perspective, the warming of the equator is expanding the Hadley cell, the vast system of overturning circulation that pumps hot, moist air upwards, producing tropical rainfall, then the same air masses descend in the semi-tropics as high-pressure ridges, blocking rainfall and creating most of the world’s deserts and arid lands. According to cutting-edge climate modelling from Columbia’s Lamont-Doherty earth science campus, the impact on lower-latitude temperate landscapes such as California will be profound.

The ongoing climate change and future change, if it follows the model projections, will transform and move Mediterranean-type climate regions. At the core latitudes of the regions, aridity will increase as winters become drier and temperatures increase through the year. On the equatorward flank some locations that are currently Mediterranean-type climates are likely to transition into subtropical desert or subtropical steppe. (Seager et al., 2019: 2911)

This is likely the future of Southern California. On the other hand, the Mediterranean climate will probably move poleward into Oregon and even Washington, threatening many forests. LeRoy Westerling at UC Merced believes this transition is fully in progress and that it explains the recent epidemic of extreme fire north of San Francisco: ‘Climate change is giving [Northern California] a climate like Southern California, in terms of the degree of drying that the fuels undergo’ (Serna and St John, 2020).

Indeed, state water planners and fire authorities since the turn of the century have been intensely focused on the threat of multi-year droughts caused by intensified La Niña episodes and stubbornly persistent high-pressure
domes. They also anticipated that the drying of forests would increase vulnerability to insect infestations and tree diseases. Their worst fears were realised in the great drought of the last decade, the biggest since the sixteenth century, which contributed to the death of more than 100 million bark-beetle-infested trees, which subsequently provided fuel mass for the firestorms of 2017 and 2018. At the same time an exponentially spreading fungal pandemic called ‘sudden oak death’ – which is also facilitated by drought – has killed millions of live oaks and tanoaks in the coast ranges from Big Sur to the Oregon border (Wheeling, 2020). Since the tanoaks, especially, grow in mixed forests with Douglas-firs, redwoods, and ponderosa pines, their dead hulks should probably be accounted as million-barrel fuel-oil equivalents in the current firestorms raging in coastal mountains and Sierra foothills (Frankel, 2007; Valachovic et al., 2011).

In addition to ordinary ‘dry’ droughts, however, scientists now talk about a new phenomenon in California, the ‘hot drought’. Even in years with average twentieth-century rainfall, extreme summer heat, our new normal, is beginning to produce massive water deficits through evaporation in reservoirs, streams, and rivers. In the case of Southern California’s lifeline, the lower Colorado River, a staggering 20 per cent decrease in the current flow has been predicted within a few decades, independent of whether or not watershed precipitation declines (Udall and Overpeck, 2016). But the most devastating impact of Death-Valley-like temperatures (it was 121ºF (49.4ºC) in the San Fernando Valley recently) is the loss of plant and soil moisture. A wet winter and early spring may mesmerise us with extravagant displays of wildflowers but they also produce bumper crops of grasses and herblike plants (forbs) that are then baked in our furnace summers to become fire starters when the devil winds return.

The invaders’ Darwinian edge

The bromes and other pyromaniacal weeds like black mustard, pampas grass, and French broom are the chief by-products and facilitators of this new fire regime. Years of research at experimental plots, where the scientists burn different types of vegetation and study their fire behaviour, has confirmed their Darwinian edge. They burn at twice the temperature of herbaceous ground cover, volatilising soil nutrients essential to the regeneration of native species. Whereas the historical fire season for the state’s major savanna and chaparral species – oak, chamise, manzanita, sage, and buckwheat – is six months long; the invasive bromes can burn anytime during the year. A study published in 2019 by the National Academy of Sciences estimated that invasive grasses ‘are already increasing fire occurrence by up
to 230% and fire frequency by up to 150%’ (Fusco et al., 2019). They also have a formidable capacity to alter soil conditions in their favour. According to UC Riverside researchers, the invaders ‘accelerate the onset of the summer drought and decrease deep soil water recharge ... inhibit[ing] the re-establishment of native shrubs and further increase vulnerability to invasion’ (Phillips et al., 2019: 1216). In addition, they sponsor the growth of microbial communities inimical to endemic plants, especially those that constitute Southern California’s coastal sage scrub ecosystem (Pickett et al., 2018).

As a result, weeds replace, often permanently, the woody native shrubs that provide net carbon storage. ‘This ecosystem conversion,’ warned scientists back in 2006, ‘has changed portions of the western US from a carbon sink to a source, making previous estimates of a western carbon sink almost certainly spurious’ (Bradley et al., 2006: 1815). Now annual firestorms kindled by weed growth are overwhelming the state’s highly advertised efforts at curbing greenhouse emissions. In seven weeks from the beginning of August 2020, megafires in California had released significantly more carbon dioxide (91 million metric tons) than produced by all the cars, cities and industries in the state in 2019 (Alberts, 2020).³

And weeds can pop up literally everywhere. It was once believed that mountain chapparal was invulnerable to the brome threat but today the wild grasses have taken over one-third of the surface area (Park and Jenerette, 2019: 460). Chapparal is adapted to intense burns within a range of 20 to 50 years, but high fire frequency – one to 15 years – ensures the dominance of invasive species and a type conversion to grasslands (Klinger et al., 2008: 185–6). Likewise closed-canopy West Coast forests have never seemed threatened because they are too cool and shaded. But a research group at Oregon State’s College of Forestry that is studying the question now warns forest managers that the species called false brome actually adapts well to forest gloom while cheatgrass immediately colonises forest burn sites. Once a durable feedback loop with fire is established, a forest grass invasion becomes, in their words, a ‘perfect storm’.

Like Weener’s Devil Grass, the invaders repel extermination campaigns. ‘Management actions,’ write the Oregonians, ‘such as thinning and prescribed fire, often designed to alleviate threats to wildfires, may also exacerbate grass invasion and increase fine fuels, with potential landscape-scale consequences that are largely under-recognized’ (Kerns et al., 2020: 2). UCLA’s Jon Keeley, a world-renown expert on fire in California ecosystems, had made the same point earlier: ‘Complete clearance can actually enhance fire spread by both increasing alien weeds that comprise flashy fuels, and by eliminating important “ember catchers” such as oak trees that can dampen the fire threat around homes’ (Keeley et al., 2010: 5). In any event, clearance by itself affords little or no protection. In 2019, Keeley and his colleague
Alexandra Syphard published the first major survey of homes destroyed in the last decade, arriving at the ‘surprising finding’ that ‘of the structures that did have more than 30m of defensible space the vast majority were destroyed in these fires’ (Syphard and Keeley, 2019: 14; Keeley and Syphard, 2019).

In other words, the textbook prescriptions for reducing fire hazards may only reproduce them in a new form – something that is poorly understood, if at all, by public officials. This is the Achilles heel of the emergency legislation that Dianne Feinstein, with the support of Governor Newsom, is trying to push through Congress that would override federal environmental regulations to accelerate the thinning of forests and the clearance of chaparral and brush. The bulldozers and torches would invite bromes into cleared landscapes without factoring in their ability to annually generate large fuel loads. Only a sustained annual effort to reseed native plants and remove, to the extent possible, the bromes and their friends – something that would require a large army of full-time forest workers and the cooperation of landowners – could theoretically postpone the weed apocalypse. It would also require a moratorium on new construction as well as on post-fire rebuilding in the most extreme fire hazard areas, but this is hardly palatable in Sacramento even in the era of a Democratic supermajority.

Wildland gentrification

Governor Newsom and other liberal leaders address every fire emergency as the result of climate change and call for urgent action to reduce emissions. In doing so, they deliberately elide the question of what needs to be done on the ground, here and now. Such an agenda would have to directly confront the continuing dictatorship of land-extensive real-estate development, especially the sprawl along what fire experts label as the ‘wildland-urban interface’ (WUI). The Forest Service definition of WUI distinguishes between two conditions. ‘Interface’ is when suburban housing is near wildland vegetation, as in the Coffey Park subdivision of Santa Rosa destroyed by the 2017 Tubbs Fire. ‘Intermixed’, on the other hand, describes the intermingling of housing with brush and trees, the case with many homes in the doomed town of Paradise, incinerated in the 2018 Camp Fire.

A majority of new housing in California over the past 20 years has been built, profitably but insanely, in such fire ecologies and by one estimate over a quarter of the state’s population (11 million people) now lives in the WUI (Lowrey, 2020). Despite the fire storms, moreover, the juggernaut seems unstoppable. According to 2018 research by Bloomberg Business Week, ‘an estimated one million new homes will be built in California’s high-risk wildfire zones by 2050’ (Flavelle, 2018). In San Diego County alone, supervisors
recently approved 10,000 new homes in ‘extreme fire-hazard locations’ in the backcountry (Smith, 2019). The exponential increase in exposure to the fire hazard can be illustrated by a recent Northern California example. ‘In 1964 the Hanly Fire in Sonoma County destroyed fewer than 100 homes. Last fall the Tubbs Fire [2017], which covered almost the same ground, destroyed more than 5,000 homes and killed 22 people’ (Flavelle, 2018). Since 40 per cent of the state’s 33 million acres of forest are privately owned (57 per cent is federal land and only 3 per cent is under state or local control), there are few restraints on future development without forceful legislative action (University of California Agriculture and Natural Resources, n.d.).

Yet such legislation, even that with the weakest wording, has always been headed off at the pass by successive Democratic and Republican governors under the sway of campaign contributors and elite voters. Thus, Newsom recently vetoed a bill that would have required local government to restrict building permits in ‘very high fire risk areas’ to only those homes that met the new fire prevention standards detailed in the bill (Weil and Simon, 2020). County ballot propositions to slow growth and protect wildlands have met the same fate up and down the coast, even in the immediate wake of local fire catastrophes. The only real restraint is the increasing reluctance of insurers to issue fire coverage, but this mainly affects ordinary homeowners not wealthy rural gentrifiers, who can easily afford higher premiums and can pay for the private fire crews recommended by the large insurers.

The uncontrolled expansion of the residential frontier into disaster-prone landscapes of course is not just a California trend: think about the building boom on Atlantic and Gulf coast barrier islands episodically submerged in hurricane storm surges. According to geographers Laura Taylor and Patrick Hurley,

> Despite the common perception that the United States has become a ‘suburban nation’ ..., exurbia has emerged as the dominant settlement pattern across the country ..., characterized by different patterns of development and different lifestyle expectations from cities, towns, and suburbs, with houses in scenic, natural areas on relatively large acreages (often with one house per 10, 20, or 40 acres or more).

(Taylor and Hurley, 2016: 1)

Instead of densifying housing on the footprints of older suburbs, especially near rapid transit, which is the rational approach to the national housing affordability crisis, market forces are poaching the wildlands and increasing car dependency while shifting the cost of wildfire protection onto county, state, and federal governments.

But there are two very different migration streams to the backcountry. Some, like the inhabitants of Paradise, the Sierra foothill city incinerated...
in 2018, are rent refugees from the state’s housing crisis or ordinary folks, especially retirees, who want to own a tiny piece of the state’s beauty. Many live in trailers or manufactured homes, blending in with traditional low-income rural populations in the shadow of declining extractive industries. But they are minor players compared to the influx of wealth from the coast. Rural areas that were once ruggedly blue-collar and derided as ‘Appalachia’ (the insult long attached to eastern San Diego County where I grew up) now boast ‘starter castles’, high-end subdivisions and spa retreats. From Mendocino on the north coast to the Sierra foothills in the east and the San Diego mountains in the south, upper 5 per cent migration has been gentrifying the urban hinterlands, especially those areas with high amenity values such as ocean views, wineries, forest lakes, and colourful local histories. Increasing numbers are second or weekend homes, affordable by those who have a solid anchor in soaring coastal home equity.

An equally prized if unspoken amenity is their racial homogeneity. ‘Exurbanisation’ is often a euphemism for white flight from metropolitan diversity. California’s high-income exurbs, regardless of their politics, are almost entirely monochromatic. Nevada County, one of the fastest growing Sierra exurbs, is just 0.4 per cent Black, while more liberal Mendocino County is 0.7 per cent. As California’s suburbs turn to technicolour and become more Democratic, the population in the WUI – especially inland from the coast – trends hardcore conservative and fiercely anti-government except in fire season. One of their leading voices was Duncan Hunter, now on his way from Congress to prison, who represented the exurban corridor along I-15 from San Diego to Temecula. For years he fought endangered species legislation and restrictions on backcountry development with the same zeal that he opposed Latino immigrants and affirmative action.

This is a mindset, blind to the consequences, that allies itself to the botanical counterrevolution. Relentless land clearance and home construction fragment habitats, introduce myriad new ignition sources and promote weed invasion. Yet the newcomers in their majority are unwilling to accept state enforcement of building material codes or proposed fire zoning regulations and raise hell when foresters attempt prescribed burns (Edgeley et al., 2020). A recent report from the National Bureau of Economic Research, summarised by two journalists from ProPublica, targeted the perversity of using general tax funds to provide fire protection to wealthy exurbanites who take so little responsibility for their own safety.

The very fact that firefighting is publicly funded decreases the incentive for WUI residents to fireproof their properties [thereby] distorting the housing market further and creating moral hazard: Because much of firefighting budgets comes out federal disaster funds, publicly funded fire response decreases
the incentive for a city or state – hello, California – to create and enforce wildland building codes.

(Weil and Simon, 2020)

Meanwhile undermanned fire crews are under tremendous pressure to defend individual home sites, making it almost impossible to adhere to the Forest Service’s doctrine of ‘disengag[ing] suppression activities immediately if strategies and tactics cannot be implemented safety’. The result has been an epidemic of deaths and injuries among firefighters. After fires, moreover, most exurbanites seem incapable of drawing the obvious lessons. In 2003 a firestorm destroyed over 1,000 homes in the unincorporated towns of Alpine and Crest in the mountains east of San Diego. When I took a documentary film crew there in 2019, the lost homes had been replaced by even larger houses and residents assured us that thanks to brush clearance the fire hazard had been mitigated. Despite their own experiences they had bought into the idea of ‘defensible space’ and the illusion that evacuation would no longer be necessary.

‘This “stay-and-defend” approach has effectively privatized disaster prevention and management by shifting fire safety responsibility to homeowners and private contractors’, making it popular amongst developers and insurance companies seeking to defend property (Galbo et al., 2020: 2). But as we have seen from the Keeley and Syphard research, firestorms that create their own tornadic weather systems and can hurl fiery debris a mile ahead of the flame front are not deterred by a 300ft circumference of brush clearance or some carefully watered beds of ice plant. Nor can ‘fireproof’ homes resist combustion when extreme heat blows out their windows and ignites their garage doors.

The victory of the weeds

How should we understand the large-scale ecological consequences of the invasive grass/wildfire cycle? One, perhaps surprising, analogue is the aftermath of the fire-bombing of Germany during the Second World War. In the late 1940s the ruins of Berlin became a laboratory where naturalists studied plant succession in the rubble. The expectation was that the original vegetation of the region – oak woodlands and their shrubs – would soon gradually re-establish itself. To their surprise this was not the case. Instead escaped exotics, some of them rare garden ornamentals, established themselves as the dominants within a new ‘ruderal’ ecosystem. As one startled but fascinated researcher emphasised: ‘The unexpected spread of foreign species made possible by the destruction of broad areas of Berlin was such a
radical event that it had rendered previous work on the flora of the city completely insufficient’ (Lachmund, 2003: 235). The botanists, who until 1961 included those from the east, continued their studies until the last major rubble site, the Dörnberg-Dreieck, which had become ‘the most intensively studied ecosystem within a city that had ever existed’, was cleared, despite loud protests, for hotel construction in 1986 (Lachmund, 2003: 244).

‘The repopulation of rubble,’ wrote another naturalist, ‘created in many cities due to the activity of bombers in the last war, has unintentionally become a tremendous natural experiment, which with respect to its size, must be compared to the populating of new habitats created by volcanic activity’ (Lachmund, 2003: 239). The persistence of this dead-zone vegetation for a generation after the war and the failure of the plants of the Pomeranian woodlands to re-establish themselves prompted a debate about ‘Nature II’. The emergent consensus was that the extreme heat of incendiaries and the pulverisation of brick structures had created a new soil type that invited colonisation by rugged plants that had evolved in on the moraines of Pleistocene ice sheets, if not at the edges of lava flows (Sukopp and Hejny, 1990: 57). The faunal velociraptor in the Berlin rubble was the evil-smelling Chinese ‘tree of heaven’ (Ailanthus), one of the most aggressive and ineradicable tree-weed species on earth, superbly adapted to every sort of human landscape disturbance from 1,000lb bombs to freeways. (In contemporary California it can be found almost everywhere, sprouting from cracked asphalt in LA parking lots, colonising foothill streambeds and so on.)

An all-out nuclear war, of course, would reproduce Berlin-Year-Zero conditions and replacement ecology on a vast scale. According to a 1960 US study, ‘under certain conditions ultimate spread [of fires] from one nuclear weapon has been estimated to be as great as 10,000 square miles’. To model such firestorms, Army and Forest Service researchers in the early 1960s used recent fires in the Santa Monica Mountains, among others in California, as analogues. They were particularly interested in the energy and intensity of wildfires in various environments, establishing a precedent for calculating fire energy in terms of tonnage of TNT (Countryman, 1964: 1). In the aftermath of Victoria’s Black Saturday fires in early 2009 that killed 173 people, Australian scientists calculated that their released energy equalled the explosion of 1,500 Hiroshima-sized bombs. Even greater energy has produced the pyrocumulus plumes that for weeks towered over Northern California and Oregon. In fact, the toxic orange smog that shrouded the Bay Area might be considered a miniature nuclear winter.

Megafires in the Anthropocene, in other words, can easily be seen as the physical equivalents of nuclear war without fallout. As a result, a new, profoundly sinister second nature is rapidly emerging from our fire rubble at the expense of landscapes we once considered sacred. Weeds and weedy species
of all kinds will continue to win victories within the new evolutionary spaces opened by climate change. And the worst is yet to come. According to a research team from Lamont-Doherty, Scripps, and UCLA, ‘the effects of anthropogenic warming on California wildfire thus far have arisen from what may someday be viewed as a relatively small amount of warming’ (Williams et al., 2019: 905). Over the next generation fuel dryness, as measured by the atmospheric vapor-pressure deficit, is expected to double. ‘Given the exponential response of California burned area to aridity’, even greater holocausts are probably inevitable, their scope limited only by available fuel mass (Williams et al., 2019: 905). Our imaginations can barely encompass the speed or scale of this catastrophe. Gone California, gone.

Notes

1 The process of invasion continues in the twenty-first century: in 2008 a new Mediterranean alien, Wards weed, arrived in the beach town of Carlsbad, north of San Diego, and, thanks to its extraordinary seed production (30,000 per square metre), rapidly spread inland. It is a notorious fire plant that invaded Australia in the 1920s and helped increase fire frequency along that continent’s arid south coast. Chances for stopping its proliferation look slim (see Diehl, 2019).

2 Three-quarters of the Mojave is deemed ‘highly’ or ‘very highly’ susceptible to grass invasion and ‘type conversion’.

3 The 257,000-acre California Rim Fire alone released as much CO₂ as the annual emissions of 2.57 million automobiles (Garcia et al., 2017: 340).

4 After the death of four firefighters during Washington’s Thirtymile Fire in 2001, the agency published the Thirtymile Fire Investigation report (www.fs.fed.us/t-d/lessons/documents/Thirtymile_Reports/30mile_actionplan%5B1%5D.pdf).

5 Half a million people were forced to evacuate during San Diego County’s Witch Fire in 2007.


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